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Ecologically Engineered Stormwater Management—Five Case Studies

SCOPE

This study evaluates the costs and benefits of using ecological stormwater management instead of traditional engineered solutions in urban environments. It is part of a larger study whose goal is to "design and test a set of management tools that will assist in promoting ecologically engineered alternative stormwater management and smart urban development."[1] Five relevant case studies were evaluated:

- The Blenkinsop Creek Restoration,
- The Willowbrook and Glanford Station Developments,

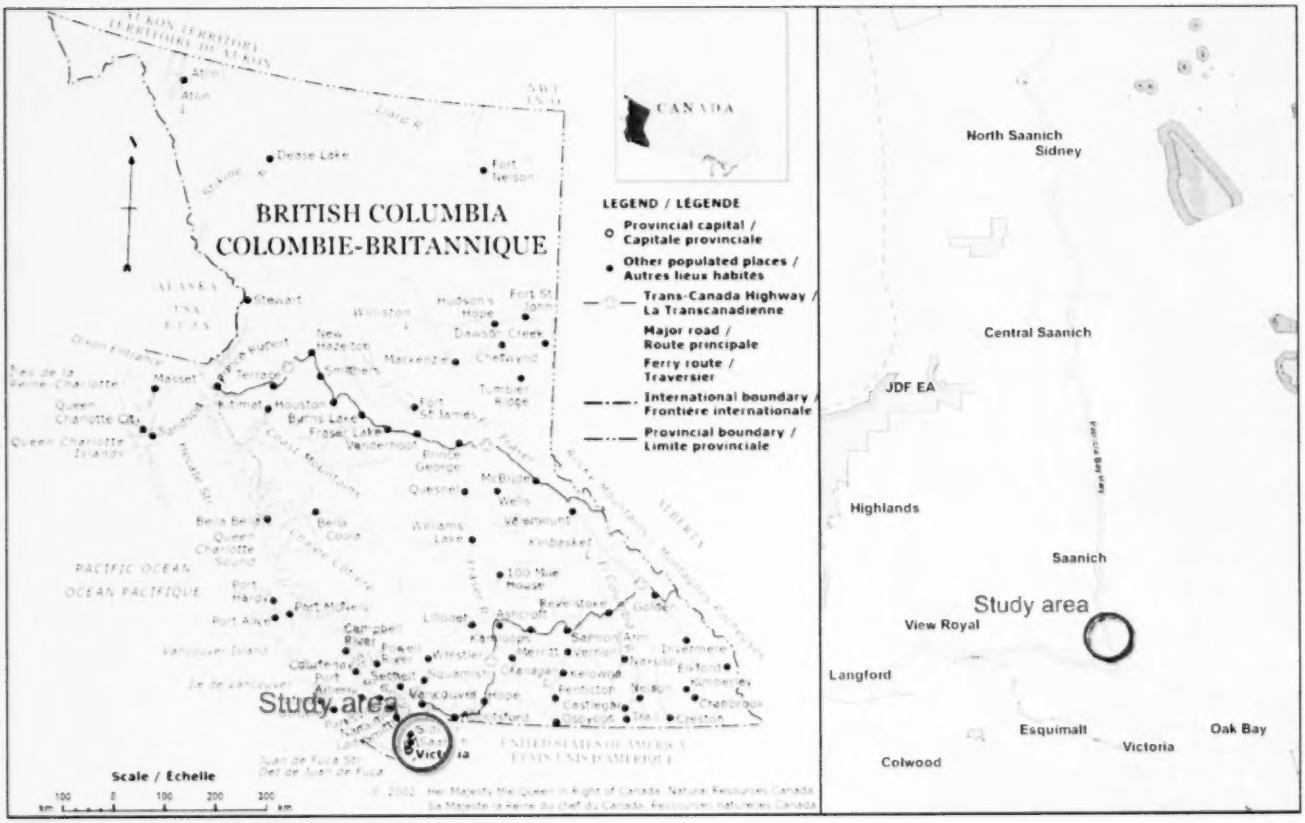

Figure 1 Location Plans

[1] Barraclough, C.L., and W.P. Lucey. (2005). Nature's Revenue Streams: Project Proposal. Aqua-Tex Scientific Consulting Ltd. Victoria, B.C.

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- The South Valley Estates Development,
- The Rogers Subdivision Development, and
- The Vancouver Island Technology Park (VITP) Development.

All study locations are within the Colquitz watershed in the District of Saanich, BC.

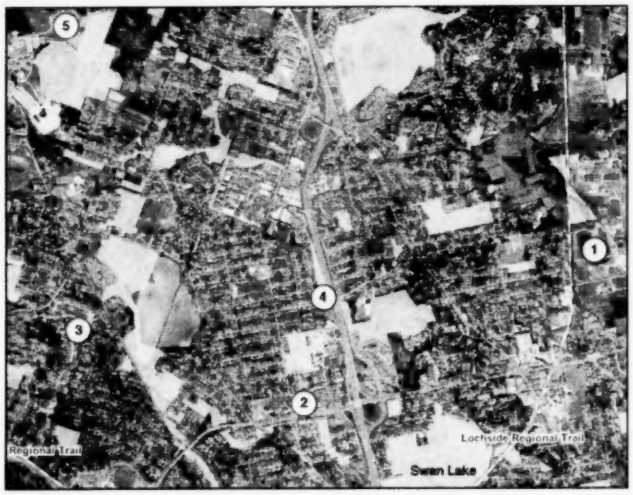

Figure 2 Locations of the Projects Examined in the Study

1: Blenkinsop Creek Restoration
2: Willowbrook Subdivision
3: South Valley Subdivision
4: Rogers Subdivision
5: Vancouver Island Technology Park (VITP)

METHODOLOGY

Case studies were selected for their potential, complexity, and probability of good analysis. They were analyzed using the Triple Bottom Line (TBL) methodology, which evaluates not only economics attributes, but also social equity and ecology considerations. Other attributes, such as cultural, were considered where necessary.

Benefits of the ecological solutions were first identified and discussed in non-financial terms, and then were compared with the most likely alternative engineered solutions. These alternatives were determined through consultation with several experts, and were cross-checked. Values of both stormwater solutions were then assigned using either direct comparison (assuming value to be the same as that of a similar project/aspect) or actual costs (assuming expenditure determines something's worth). Note that costs considered not only initial outlays, but also long-term operations and maintenance (O&M), which were evaluated over 25 years and reported in present value (PV).

All attempts were made to adhere as closely as possible to the valuation standards and guidelines developed by the United Nation's International Valuation Standards Committee (IVSC). However, given the lack of data meeting IVSC criteria, supplementary information from published literature and proxy data were used where necessary.

Blenkinsop Creek Restoration

Project description: On Galey's farm in the Blenkinsop Valley, a drainage ditch running through the farmer's fields was moved to the property edge and rehabilitated into an ecologically functioning creek. Hard costs amounted to approximately $375,000. A similar-sized ditch constructed using traditional methods would have cost approximately $5,200.

Key value findings:

- Moving the creek increased arable land by approximately 1.5 acres; this land is estimated to be worth $75-90,000.
- Although unanticipated, ecological creek activity halted the need for pesticide use. As a result, over 25 years, the farmer is estimated to save $497,657 in spraying costs.
- Since creek restoration, the farmer has been able to supplement irrigation by drawing creek water from a sub-surface system, which is estimated to provide $8,548 in potable water savings over 25 years.
- Vandalism and theft caused by people passing through the Galey property via the former ditch was estimated to cost close to $100,000 per year. This has reduced since the creek moved, resulting in an avoided cost of $1,409,395 over 25 years.
- Flood protection provided by the creek is estimated to amount to $765,484 over 25 years, based on information provided in the literature.
- Additional ecological benefits included increased bird populations, restored biodiversity, reduced need for plant replacement, improved water quality, reduced bank erosion and subsequent sediment loading, reduced nutrient input, decreased downstream flooding, reduced greenhouse gas emissions, and additional carbon

sequestration. Although these benefits are difficult to quantify, a rough estimate of $12,006 in net primary production was estimated, and a PV of carbon sequestration of $496 over 25 years.

Summary: Despite the large discrepancy in initial costs, this is a viable option for both the farmer and the community. Creek rehabilitation net benefit to the farmer is expected to reach $1.6 million over 25 years, with an additional $4.0 million accruing to the municipality and surrounding community.

Willowbrook and Glanford Station Developments

Project description: Willowbrook Subdivision is an in-fill development of 31 single family homes on former agricultural land. During construction, an agricultural drainage ditch was relocated and restored as a functioning creek (Swan Creek) that now runs through a park. Ecological stormwater measures included the construction of six ponds, the rehabilitation of 750 metres of fish-bearing creek, and the use of a sewer right-of-way for additional wetland treatment. Glanford Station, directly northwest of Willowbrook, comprises 22 new and detached single-family homes, plus six pre-existing homes. Stormwater from Glanford Station drains into a cascading series of constructed ponds and wetlands before joining the rehabilitated Swan Creek. For the purpose of this study, both projects were analyzed as one, and were estimated to cost the developer $120,000. A traditional engineered solution would have included storage tanks and pumps, and would have cost between $260,000-300,000.

Key value findings:

- Community and regulatory support for ecological solutions expedited the approval processes to only 63 days (normal approval times range between two and three years). Cost savings likely resulted, but have not been quantified.
- Not only did the municipality donate 17% of the land (as dedicated parkland), they also agreed to relax building setback and lot size requirements in Willowbrook, and allowed the developer to use a city-owned utility corridor to accommodate stormwater treatment in Glanford. These measures enabled the developer to increase lot count and hence revenues by an estimated $850,000.
- The ecological approach is estimated to save the municipality $13,503 in O&M costs over 25 years.
- Ecological benefits, including improved water quality, increased biodiversity, and carbon storage and sequestration are expected to provide a further $15,150 in savings over 25 years.
- Many schools in the area use the stormwater ponds and parkland for education, and the resulting educational value over 25 years, is estimated to have a PV of $34,345.

Summary: Both the municipality and developer obtained value from using the ecological approach (approximately $60,000 and $965,000, respectively).

South Valley Estates Development

Project description: In the Wilkinson Valley, an area of small acreage holdings are being developed into an urban infill of single family detached homes and townhouses known as South Valley Estates. Ecological stormwater management practices incorporated into the subdivision include the relocation and restoration of part of Peers Creek, and the development of a trail, park and a bioswale in an existing sewer right-of-way. Partial use of grasscrete instead of pavement has also been used in one section. Comparable alternative engineered solutions would include standard curb and gutter roads with stormwater drains and piping. Costs were not available for this project owing to privacy issues.

Key value findings:

- Visual appeal was substantially improved, which may or may not have increased house sale values. More likely, it helped reduce time required to sell out the project.
- Owing to regulatory requirements, the bioswale and creek did not replace but duplicated traditional engineered solutions, and so there were no initial cost savings. On the plus side, some regulatory setback flexibility enabled the developer to maximize lot density and so increase revenues.
- Although cost savings from using grasscrete in place of asphalt are small, tree roots and water flows are disturbed less with grasscrete, and so there is a small ecological benefit.

Summary: The municipality's strict adherence to existing standards and policy requirements ultimately increased costs and impacted the project's value and the developer's revenue. Inflexibility regarding trail widths and permeable paving application may have doubled sidewalk widths, thereby increasing stormwater run-off.

Rogers Subdivision Development

Project summary: Rogers Farm is a 72-house development on Christmas Hill situated directly east of the Patricia Bay Highway (Highway 17). To manage the subdivision's stormwater, a former municipal fill dump on the opposite side of the highway was restored and expanded to become Baxter Pond. The land was donated by the municipality, and total costs to the developer amounted to an estimated $75,000. The alternative engineering solution would have been drains and on-site reservoirs, which would have required blasting and excavating of bedrock and cost an estimated $275,000.

Key value findings:

- The creek is too far away to add value to subdivision house prices, and so the net economic benefit to the developer is largely the cost savings arising from using the ecological alternative ($200,000), plus additional lot yield ($345,000).
- The direct cost savings to the municipality was $75,000 for reconstruction of the pond. Other community benefits included carbon sequestration and storage, educational value, and social benefit, which amounted to a PV of approximately $123,466 over 25 years.
- Although not quantified financially, the pond also improved water quality, sediment capture and stormwater storage, while reducing downstream flooding potential. It also accommodated additional flows from the highway and other nearby subdivisions, and also provided the public with increased aesthetic value and an improved trail.

Summary: Both the municipality and developer achieved net benefits by employing the ecological approach ($121,448 and $535,000, respectively), and the public also gained. Furthermore, the project set a precedent for treating stormwater on municipal property that may be applicable to other situations.

Vancouver Island Technology Park

Project summary: A former provincially-owned hospital for severely disabled patients was renovated into the Vancouver Island Technology Park (VITP). While the original project budget had not allowed for any "green" features, rising construction costs inspired alternative solutions, and the building ultimately achieved the Leadership in Energy and Environmental Design (LEED™) Gold standard. Stormwater specific solutions included:

- creek restoration,
- permeable paving materials,
- swale restoration and curb cuts,
- waterless urinals, dual flush toilets, infrared sensors, shower flow restrictors, and future rainwater collection, along with future zero landscaping,
- wildlife habitat restoration and preservation of 99% of the original tree population.

None of the costs for the non-green VITP design were available. Engineered solutions used for comparison were traditional asphalt paving lots.

Key value findings:

- Overall, VITP demonstrated that sustainable approaches can be used without incurring additional costs.
- Installing permeable materials instead of a traditional asphalt in the parking lot saved the owner infrastructure costs, as well as associated maintenance and capital replacement costs, providing a net PV benefit to the owner of $543,147 over 25 years.
- Certain ecological components could not be adequately isolated to prove distinct added value. However, discussions with stakeholders indicated that green amenities such as wetlands are believed to have helped achieve the 20% faster lease-up experienced.
- Appraisers were unable to identify any initial rent increases attributable to the green initiatives; however, the lower utility costs expected in a LEED™ building may enable future rent increases, as tenants will be able to afford higher rents while maintaining the same total operating costs.

- One detriment noted here is that little corporate memory of the original development principles remains, and already the parking lot is showing damage from improper care. This is likely to increase costs and elicit proposals to replace the sustainable infrastructure with more traditional solutions unless re-education can be undertaken.

Summary: Because VITP is something of a test project in British Columbia, cost savings were not as high as they might be today, given a greater experience with sustainable approaches. Still, a net benefit to the developer was achieved. The municipality has also received economic benefit, estimated to be $280 million in direct, indirect and induced revenue, and the community benefited from the expanded trail systems and restored creeks, as well as the educational benefits these facilities accrued.

CONCLUSIONS AND RECOMMENDATIONS

Data quality: There were difficulties in obtaining cost and value data for virtually every project. Much of this can be attributed to:

- the "pilot" nature of the projects, which meant that many benefits not foreseen at the outset, were not sufficiently tracked,
- privacy and commercial interests and confidentiality issues, which restricted some information availability,
- lack of quantification, which significantly hampered the analysis, and
- little or no incentive for those supplying the information to support this study, which meant that data was largely insufficient or simply unavailable.

To help remedy this, pre- and post-completion audit processes should be set up prior to project commencement, and the following recommendations should be considered:

- Criteria success measures should be defined prior to project commencement, and a formal review process post-completion should be considered to evaluate if criteria are met.
- Baseline assessments should include the main aspects likely to affect each stakeholder, and any changes to these aspects should be assessed during the project, upon its completion, and periodically thereafter (for long-term aspects).
- Triple Bottom Line methodology should be used in project reviews. Full Value Accounting should be undertaken where possible, even if non-financial aspects are difficult to quantify, and proxies must be used.

The report also made some recommendations specific to stormwater infrastructure studies:

- Ecological stormwater management savings should be calculated based on comparisons with scalable alternative models like parking lots, roads and buildings.
- Calculations should include: sequestration benefit, biomass-harvesting frequency, greenhouse gas reduction, and cost/maintenance impacts. Value benefits arising from a property's proximity to greenspace may not be quantifiable, but some discussion and an attempt to model this benefit should be made.
- Savings should be separately enumerated (i.e., piping and pumping cost savings must be separate from maintenance savings).
- Water flows should be modeled. This would allow benefit recalculation for other, similar projects by simply adjusting the model to reflect local circumstances.

Regulatory barriers: Throughout this study, regulatory obligations and practices consistently acted as barriers to implementing ecological solutions, and this was often compounded by professional and political reluctance to change. While community support helped expedite many approval processes, it is not known whether this reduced development charges. Since these charges are collected to cover municipal infrastructure costs, and ecological systems reduce the burden on these systems, there should be a lower charge for ecological projects. To encourage and foster sustainable development, the study's authors recommend that regulatory agencies should consider establishing the following policies:

- Offering variances and density bonusing to developers in exchange for restored amenities, such as open space.
- Utilizing development control bylaws to encourage improved streetscape, pedestrian environment, view protection, overall site design, and compatibility with landscape function and aquatic ecosystem (where applicable).

- Requiring that site designers reduce the amount of impervious surfaces, to incorporate features that encourage groundwater recharge (such as pervious paving), and to consider ecological stormwater management.
- Ensuring that policies are consistent among municipal departments.
- Supporting an understanding of growth and sustainable development best management practices through public events and information distribution.
- Incorporating "green" building support systems, such as green roofs and energy/water use monitoring, into the building as design features and made visible to the public where possible, to encourage accessibility.
- Working to acquire private land for trail rights-of-way, easements, or other services like flood protection, either by asking landowners for land donation or offering payment for services provided.

Valuation methods: These case studies show that "green" initiatives can be completed at the developer's cost instead of through taxpayer revenues. Projects with a heavy stormwater engineering component are especially likely to benefit from ecological solutions. Greater benefits could be achieved by always comparing these solutions to their traditional engineering alternatives, using both market based and non-market based valuation methods. The study's authors argue that a Public Interest Value approach is needed, one that considers not only a Triple Bottom Line assessment of a project but also evaluates how much cost or benefit there will be for each stakeholder. For this to effectively drive development, some form of transfer mechanism may be necessary to distribute benefits and costs fairly among the parties involved.

IMPLICATIONS FOR THE HOUSING INDUSTRY

Ecological stormwater systems can offset infrastructure costs, reduce a development's environmental impact, and lessen chances of downstream flooding and hence flooded basements. It also has the potential to create more visually appealing neighbourhoods, if incorporated properly, which may add sales value.

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Under Part IX of the ***National Housing Act***, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

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